



USAISEC

*US Army Information System Engineering Command
Fort Huachuca, AZ 85613-5300*

②

DTIC FILE COPY

U.S. ARMY INSTITUTE FOR RESEARCH
IN MANAGEMENT INFORMATION,
COMMUNICATIONS, AND COMPUTER SCIENCES
(AIRMICS)

AD-A218 301

Technology Insertion – Migration and Distribution of Applications

(ASQBG-A-89-038)

November, 1988

DTIC
ELECTE
FEB 22 1990
S B D
CO

AIRMICS
115 O'Keefe Bldg
Georgia Institute of Technology
Atlanta, GA 30332-0800



DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

90 01 30 008

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704--188
Exp. Date: Jun 30, 1986

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS NONE	
2a. SECURITY CLASSIFICATION AUTHORITY N/A		3. DISTRIBUTION / AVAILABILITY OF REPORT N/A	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A			
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ASQBG-A-89-038		5. MONITORING ORGANIZATION REPORT NUMBER(S) N/A	
6a. NAME OF PERFORMING ORGANIZATION AIRMICS	6b. OFFICE SYMBOL (if applicable) ASQBG - A	7a. NAME OF MONITORING ORGANIZATION N/A	
6c. ADDRESS (City, State, and ZIP Code) 115 O'Keefe Bldg., Georgia Institute of Technology Atlanta, GA 30332-0800		7b. ADDRESS (City, State, and Zip Code) N/A	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION AIRMICS	8b. OFFICE SYMBOL (if applicable) ASQBG - A	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code) 115 O'Keefe Bldg., Georgia Institute of Technology Atlanta, GA 30332-0800		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO.	PROJECT NO.
		62783A	DY10
		TASK NO.	07
		WORK UNIT ACCESSION NO.	
11. TITLE (Include Security Classification) Technology Insertion- Migration and Distribution of Applications (UNCLASSIFIED)			
12. PERSONAL AUTHOR(S) G.J. Dunleavy			
13a. TYPE OF REPORT	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) 1988 November	15. PAGE COUNT 18
16. SUPPLEMENTARY NOTATION			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This paper examines the migration of applications from a current environment to future use. The author looks at the factors involved in the migration and how technology insertion can aid in the migration of applications. Also discussed is the criteria and methodologies used in the migration. →			
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED / UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL Michael J. Evans		22b. TELEPHONE (Include Area Code) (404) 894-3107	22c. OFFICE SYMBOL ASQBG - A

This research was sponsored by the Army Institute for Research in Management Information, Communications, and Computer Sciences (AIRMICS), the RDTE organization of the U.S. Army Information Systems Engineering Command (USAISEC). This paper examines the migration of applications from a current environment to future use. This research report is not to be construed as an official Army position, unless so designated by other authorized documents. Material included herein is approved for public release, distribution unlimited. Not protected by copyright laws.

THIS REPORT HAS BEEN REVIEWED AND IS APPROVED

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

s/ James Gantt
James Gantt, Chief
Management Information
Systems Division

s/ John R. Mitchell
John R. Mitchell
Director
AIRMICS

Table of Contents

1. Introduction	1
2. Overview	3
2.1. Hardware	3
2.2. Transport	4
2.3. Software	4
3. Factors involved in Application Migration	4
3.1. General	4
3.2. Areas of Analysis	5
3.3. Steps in Selection Process	7
3.4. Categories of Applications	9
3.5. Process involved in Migration	10
4. Technology Insertions role in Application Distribution and Migration	11
4.1. Demonstrated Technology Insertions	11
4.2. Hardware and Transport.....	11
4.3. Software	13
5. Criteria for Migration of Applications	14
6. Methodologies employed in Application Migration	15
6.1. Redesign and Recoding in Native Language	15
6.2. Redesign and Recoding in ADA	15
6.3. Optimizing in Present Processing Environment	16
6.4. Redesign of Processing and Transport Architecture	16
7. Conclusions	17
8. Recommendations	17

1. INTRODUCTION

Before we can logically address migration of applications from Tier I to Tiers II or III we should know what it is we are proposing to migrate, and why it is necessary to do so. Once we establish the what and why we can then work the issues of how and when.

The U. S. Army owns and operates a vast system of heterogeneous processing and communications systems. Collectively this grouping of systems and subsystems has been dubbed the IMA Resource.

Corporately, on a notional level, these assets are managed and operated as a homogeneous resource. The DISC4 is assigned the task of articulating the management of the Information Systems Resource. A first cut architecture, the Three Tiered model is described in AR25-1.

The Information Systems Resources have the ability to provide the managers of the Army with automated assistance in performing the Go-To-Work and Go-To-War missions. The degree to which the automated systems perform these functions and the speed and quality of the work performed portends some measure of efficiency relative to needs.)

Today's Army must cope with an opposition force which is numerically larger, well equipped, and strongly positioned. The Information Systems Resources of the Tactical/Strategic and Sustaining Base must be coordinated and tightly integrated to provide the necessary control and support relationships from the basic combat unit up through the National Command Authority (NCA) and across the units at like echelons of the hierarchy. (KR) (—)

Situations dictate needs. An armor unit performing training in an OCONUS situation as part of a Joint Force has different needs than an armor unit in garrison. A deployed and engaged unit fighting a limited objective conflict with a non technical opponent such as a third world power has different needs than they would if they were engaged as part of a global conflict with a technically equal opponent such as the Soviet Union. In any scenario, the outcome of an engagement will most likely favor the force which is best prepared and capable of sustaining some advantage over the opposing force. Not every battle has a grand plan. Units, particularly lower echelon units, frequently engage not as part of some mass battle plan, but because they simply run into each other. The choice to engage or to not engage may or may not be a planned action. Each side will prefer to engage when they

perceive an advantage which portends a successful outcome. The Information Systems Resources are both active and passive force multipliers in the overall equation determining the outcome of these engagements.

The force with the lesser resources will avoid an engagement with a superior force whenever possible. Winning a war involves sustained offensive action. No one has ever won a war in a purely defensive mode. In an engagement with the Warsaw Pact or China for that matter, the allied forces will be in a defensive mode at the outset. The offensive force, particularly the Shock Echelon, has very little need for communications or battle management. The defending force on the other hand has an extreme need for information relative to the intent and objectives of the offensive force(s), and must also be able to evaluate the merits of where, when and how to engage the offensive force with an objective of stalling the offensive thrusts and turning to the offensive with his force. FM 100-5 measures a force's effectiveness on the basis of responding to situations more rapidly and effectively than does an enemy force. This is an after-the-fact measurement with potentially fatal results for failing the test.

The Army initiative in the Army Tactical Command and Control Systems (ATCCS) is directed at providing the Elements of the Sigma Star with the required tools to provide tactical advantage via C4I coordination and cooperation.

ICS/ISEC must carry the coordination and cooperation from the Echelons Above Corps (EAC) to the NCA levels and everything in between. ATCCS can provide support on the battle field up through the limits of available resources. Resources in this case applies to manpower, logistics, ordinance, maneuver control. Replenishment of in-theater resources falls on the EAC.

No force has unlimited logistic support. Ordinance is expended, food is consumed, and people die. **Sustainment** is the key to the outcome. Sustainment is logistics. Logistics is source materials and the ability to make them available when and where they are needed and in the right quantities.

Destruction of any of the key elements in the logistic chain will cause the war to stop. Deny a force food, water or POL and the war is over. Denial via conventional forces portends a protracted war of attrition. Nuclear, particularly dirty nuclear weapons, or chemical/bacteriological weapons are another story. Not withstanding on what terms the engagement is conducted, logistics and resupply to sustain offensive actions are critical to the ultimate outcome of the engagement.

The Information Systems Resources support the utilization of resources and the resupply actions. In the early stages the Information Systems Resources (C4I) will support the combat units with Decision Support which will provide critical information relative to where, when and how to use the available resources to best advantage. A decision to withdraw from a contact may be as critical as one to engage in the very early stages of any conflict. Preservations of resources until such time as equity or advantage can be realized is critical. Equally as critical may be the decision to break off an engagement because it is reducing the available resources at an unacceptable rate.

History is replete with "Lessons Learned" examples which point to two factors resulting in defeat. Lack of information or the failure to act upon available information.

We have the technical wherewithal to insure that we do not do succumb to either of these shortfalls. The linkage between the Sustaining Base/Strategic/Tactical Information Systems resources must be reinforced and coordinated to insure that they are both functionally sound and optimized for performance.

2. OVERVIEW

2.1. Hardware

As was previously identified in Task #1 and #2 of this contract, there are numerous areas where significant inefficiencies exist in the current software running at the Tier I through Tier III levels. The inefficiencies attributed to hardware are on the surface relatively easy to correct. Hardware/Software and Transport must be optimized to a run-environment performance level consistent with response requirements. Functionality is not enough to insure performance. Time domains must be brought to the fore and architectures and system designs keyed to provide the optimum performance consistent with need. One could assume that this means a constant shift in technology or a program of everlasting technology insertion. The fact of the matter is the process of designing to performance requirements will lessen both the uncertainty of how much is enough. The Army could then put a front and back cover on the Information Systems needs. The objective is to get the proper amount of technology and response into the system and to avoid technology just for the sake of technology.

2.2. Transport

Transport is a difficult issue to deal with, but with proper planning it can be sized and acquired relatively quickly. What should be avoided is planning and implementing transport facilities without regard to the potential for major changes in the basing posture of US forces.

Much has been said in recent times regarding burden sharing. Fixed-plant transport resources appear to be one area where a case can be made for host nation cooperation. The transition to a more real-time support environment will foster needs for wider bandwidth to service the more time/data intensive applications.

2.3. Software

That leaves software which is the most difficult part of the problem. Off-the-shelf software, while readily available, can't handle the scope of the tasks the Army demands of it at Tier I. Users at Tier III are either driven by the dictates from Tier I or they use this off-the-shelf software because it is all they have. At the Tier I level, applications development has been the traditional answer to the problem. Most of the major applications were originally developed to Army specifications by commercial contractors. Some of the work was done internally by ISC but the amount of development has been very limited. Most, if not all, of these applications have outlived their original design goals for many reasons. The system architecture has changed or it needs to be changed. The applications have also been overcome by technology such as the development of newer and more efficient languages and coding techniques. The functional need may have even changed. In other words, they are obsolete. The central purpose of this WHITE PAPER is to identify and address the issues related to the migration of selected existing applications from their current state to a target state and configuration.

3. FACTORS INVOLVED IN APPLICATION MIGRATION

3.1. General

Application Migration is a process of identifying existing applications which have become obsolete and then, through the use of one or more techniques and methodologies, converting those applications into ones which are more responsive to users functional and performance needs. The improvements in responsiveness to users must be balanced against the increasingly important requirement for applications to

efficiently utilize their resources, specifically hardware (example: CPU cycle times) and transport (example: moving the smallest amount of information possible i.e., transactions instead of whole data base files). Another resource not often considered in the development or redesign of applications in the sustaining base environment is the commander or manager which must act upon the information provided to him or her. We are at the point where we can literally flood the commander with rivers of data and yet provide him with very little information. In the redesign and optimization of software then we must carefully consider the delicate balance where we provide the commander with just enough information to aid in his decision making but at the same time to give him enough information to afford him the confidence to make that decision.

3.2. Areas of Analysis

The process of Application Migration is one which is relatively straight forward after the decision to migrate has been made. Before the decision to migrate is made much analysis is required. This analysis and the preparations necessary before implementation of the migration require extensive planning and coordinated staffing action at many levels (operational and staff). The actual migration will entail efficient software development through the use of modern coding techniques and tools. In conjunction with coding/recoding and redesign, the utilization of technology insertion schemes must be carefully chosen to pick only those advancements which are most cost-effective and that provide reasonable technology. The goal is to seek a proper mix of simple, dependable techniques and sophisticated, complex technology.

Many factors weigh heavily on the utility and practicality of any application migration scheme. Some of them are:

- o System Performance Requirements
- o System Architectures
- o Data Base Structure
- o Data Base Query Routines
- o Operating System Features and Limitations
- o System Security
- o System Bandpass Availability
- o Nature of the application
- o Form of the data
- o Form and Frequency of Input/Output
- o Information Content of the Data

Gupta and Madnick in their "Overview of Knowledge-based Integrated Systems Engineering -- Objectives and Directions" take a slightly different tact in that they identify technical deficiencies which are traceable to the nature of

heterogeneous systems. They identify the following deficiencies:

- o Structured and unstructured applications;
- o Information versus knowledge;
- o Diverse types of information;
- o Semantics;
- o Communications;
- o Granularity; and
- o Security.

There can be little doubt that the system(s) of today must transition to one which are knowledge-based and integrated. Moreover the introduction of the knowledge-base and integration must begin in the lower echelons of the system and traverse all levels from high to low. When asked about centralized vs. decentralized development issues in a recent interview James Martin said "You really want to build the application where it will be used, because there are all sorts of subtleties, understood only by those who work on the shop floor.". The translation of that statement is that it is important for the Army to understand that the needs of the user should be considered but that does not mean they become the driver in the redesign process. Most users have trouble seeing the forest for the trees. Equally important, the ARSTAFF is so far from the problem that they have trouble seeing the trees in the forest. The most logical solution for this common type of problem is for the key figure, the proponent, to become very active role in the detailed work necessary in the migration of any application.

In order to make this goal attainable it is necessary to understand and articulate the nature of an application and to establish it's relationships with all other applications to which it is logically connected either as a user or as a donor. The associative relations are extremely important in the process of optimizing both the processes and of data.

New techniques are emerging which will permit easy, intelligent, and efficient access to information hosted on multiple heterogeneous systems. The basis for the new techniques reside in the development of stand-alone and integrated knowledge-based systems, and the integration of the intelligence content of these programs with the applications and data bases. This emerging class of helper programs also provides a path to interface analytical tools which will aid in the design, implementation and operation of the fielded systems. Dynamic optimization of an applications run environment will be possible when we have sufficient data in hand concerning the form, function, relationships and performance requirements of an application.

Applications, are in fact rarely single programs but collections of program elements operating in a sequential,

cooperative mode to produce some preordained result or class of results. STAMIS are one prime example of large, complex, applications. The present design is optimized for centralized batch processing. There exists time restrictions at every step of the batch oriented process. If these applications are to be redesigned and modernized to meet realistic time constraints appropriate to support of a highly mobile Army with it's dependency on large volumes of data in very short time frames, the basis premise of support must change. Accordingly, the hardware/software and network services must be optimized to support the performance requirement not just the functionality of the processes. The current processes must be benchmarked against a set of target performance goals which reflect need during a conflict situation.

3.3. Steps in Selection Process

The first step in the modernization and redesign process might begin with an assumption that the functionality of the existing processes are consistent with the mission needs.

The second step is to upgrade the performance of those applications which do not meet the required time-line performance requirements. The proponent is the source of the required functional and performance data. Those which meet both functional and performance goals should be left as they are. The net effect is to place these applications at the bottom of a priority list for redesign and modernization. Maintenance of these applications in their present form will be considered as a cost of doing business in the present and transition phases. Relationships to other redesigned processes may at some point dictate modification or redesign, but for the present these systems should be treated as adequate.

Priority should be placed on redesign of the Go-To-War processes. These processes should be traced across the Sustaining Base/Strategic and Tactical environments and standardized in content and run-environments. Data elements must be identical, data views must be constructed which support the missions of the upper and lower echelons, transit and processing should employ intelligent handling routines which include contingencies which may isolate elements from the prescribed architecture for extended periods of time. The Hardware/Software/Transit compliments should also provide for reduced capabilities modes of operation. The paramount design objective is to continue information flow up and down the C2 chain.

It is not possible or practical to ignore the Go-To-Work systems while the priority upgrade concentrates on the Go-To-War systems. The priority for support and maintenance of the Go-To-Work segments should be clearly identified and

the funding needed to support that class of services separated from Go-To-War.

One perception which must change is that the Tactical Information Systems are the Go-To-War assets and the Sustaining Base and Strategic systems represent the Go-To-Work assets. The three are linked and dependent one upon the other to insure that the mission can be accomplished in Peace, Transition and War. Until such time as we are able to propose a single system solution which has instant access to the World Data View this dependency will continue.

ATCCS ACCS-CHS has made a major stride along the path to elimination of deficiencies and toward improving the responsiveness of the Information Systems Environment. A shadow program for the EAC through the NCA is required to insure that the data produced within the Sigma Star elements is translated at the EAC. The application programs in the tactical environments and the processes should be identical below Corps and at the EAC and above. CICA may force the selection of different hardware vendors but the run environments and the ability to handle the granularity of the I/O, application processing and communications should not be impaired by this decision. The equipment should not be so diverse as to require different skills levels for support in any of the three segments of the IMA. Similarly support requirements for applications software should be constant.

The Army does not have the market muscle needed to bring about the degree of standardization that is required. It must be a cooperative venture of the military, industry and the Congress. The U.S. no longer dominates the world-wide electronics market place, and some of the decisions which need to be made regarding the degree of standardization will be viewed by industry as opening up their technology to exploitation by others. The Army has very little power to counter this contention except on the basis of common sense and past history. Standardization has not been the dominant reason for the US loss of world-wide market share. The solution can only come from industry and the congress. DOD's policy supporting CICA has done little to counter the flow of key technology or to foster the basing of key technology in US concerns. We are finding that many of the key components of the modernization must come from off shore sources. The Army can not be subjected to statutory policy which creates increased cost and complexity in the modernization process.

Before departing this topic area, it should be noted that the degree of application transparency and the skilled employment of knowledge-based support systems is very important to the user acceptance of the redesigned application. However, the user at the worker level and the user as a commander must trust the new programs to make the right decisions about what is, and what is not brought to their attention. The right

application of AI and DSS will do just that. The man will continue in the loop, because there is not now nor is there likely to be any substitute for human judgement. There must be a blending of human and machine content and establishment of trust between technologist and the users.

3.4. Categories of Applications

The application layer of software in Army systems can be categorized as stand-alone and self contained, where all I/O processing, and reports are generated on assets organic to the user who performs the entire operation and consumes the results on his level. Administrative word processing is one example of this type of asset.

A second category, probably the dominant application level involves conversion of the stubby pencil, manual applications to some form of input and transmitting it up a chain as either input with no reply required or with some feed back expected. The vast majority of this type of information deals with the lowest levels of the Army or with record communications. Very obvious deficiencies exist, particularly within the Reserve Components (RC). Inputs to WWMCCS Information System (WIS) and WWMCCS Entry System (WES) are in many cases manual and at some point in transit the interface is via tennis-shoe or some equivalent inefficient method.

The Army has had CAMIS/RCAS on the books as a programmatic solution to the major deficiencies in the RC area for about a decade. One of the major problems in getting this program underway is the RC's rejection of the need to buy into the modernization of the STAMIS and other Active Component (AC) software applications. The RC has also spent an inordinate amount of time documenting difference in operations rather than concentrating on the unifying side of the equation. The AC has been very open concerning the state of STAMIS applications and the need to modernize and redesign. The Army can not afford to have divergent applications where the missions and goals are the same. Likewise the solutions must be the same. Divergent solutions at any level complicate the mission and detract from optimization of performance on both a personal and system level.

The Army has undertake to produce a set of standard software applications targeted at Post/Camp/Station Information Systems needs. This grouping is the Army standard Installation Support Modules. The ISMs are mainly Administrative Support Modules which will be processed on the ASIMS in it's present form. The ISMs will provide the standard interface to the higher level STAMIS which will run on Tier I and II assets. The vast majority of the applications are well suited to batch processing. The ISM's should be extended to the RC and integrated as a donor and

user of the higher echelon data views which will emerge as system integration progresses.

The data originated in both AC and RC STAMIS programs should be merged to the level of commonality. Differences in the SOPs should be accommodated via Tier III assets. Unique applications whether AC or RC should be relegated to Tier III. If an application can not be resolved by either stand-alone or peer-to-peer processing, the requirement should be treated as a DA controlled operation. The program would be entered into the IMMP and LARRDEP thus insuring oversight and accounting for personnel, processing and transport resources. The same data standards which apply to STAMIS must be applied to uniques.

3.5. Process involved in Migration

The structuring of the processes involved in Migration include a review of the following items:

- o Prioritize existing STAMIS into those requiring modification and those which do not
- o On candidate redesigns parse the applications into their component parts: I/O, processing, data storage, etc.
- o Redesign objective is ADA. The advantage is the use and reuse of common modules
- o Define performance parameters of redesigned applications . Set limits on query preparation, processing , data base access, result, et al. This needs to be defined to the level of granularity of the application objective. Some will use very extensive cooperative processes while others will have few processes.
- o Identify all interface and interoperability programs and processes.
- o Calculate storage requirements and identify where data will reside and why.
- o Calculate processing requirements
- o Limitations/improvements and/or interoperability of the operating system or executive software required by the hardware.
- o Is the Operating System capable of multi-user and/or multi-tasking and on-line, interactive response

- o Calculate through-put requirements on the transport facilities
- o Identify overhead elements.
- o Calculate run-environments (model basic and alternatives.
- o Structure the form of the exchanges between all levels in the processing chain.
- o What requirements exist or are contemplated which demands application portability within the Sustaining Base and the Strategic/Tactical areas

4. TECHNOLOGY INSERTION ROLE IN APPLICATION MIGRATION

4.1. Demonstrated Technology Insertion

State-of-the-art developments are abundant in the area of hardware, software, and transport. Hardware developments are forging far ahead of software development and, in fact, it is doubtful that software will ever catch-up with present rate of hardware advances. Hardware prices continue to plummet as a ratio to the rapidly increasing processing power and decreasing size. It is important to note here that industry has made substantial gains in the time frame required between introduction of a chip set to the time product is available employing the advanced products. The 80486 chip set will be hitting the market any day now. Likewise the 68030 is already finding it's way into workstation products. Two vendors (IBM and Compaq) have announced products which will include the 80486 before the chip set product hits the market. How are they getting product out concurrent with delivery of the first production chip sets? Both vendors have gone to emulation, modeling, and simulation of the 80486. Estimates place the time saving for introduction at about one year. With each successive new hardware product introduction we get closer to a position of equality of performance between PC based equipment and pre 1980 mainframes. The memory densities and cycle times are such that one might logically consider porting entire processes from mainframe to PC.

4.2. Hardware and Transport

Assuming that some number of applications are ported to Tier II and III assets what then is the net gain at Tier I? Clearly, the cycle times for the batch oriented processes can be reduced. Adding FEP and back-side data bases strengthens

the number of options the IMA manager has in hand to provide services. Consideration might also be given to grafting on to this compliment a supercomputer or subsuper to off-load some of the numerically intensive routines, which will have a net effect of reducing cycle times thus making data more current. If one considers the addition of front-end, computation intensive machines for standard number crunching, it becomes equally practical to employ the same relationships to perform highly iterative analytical tasks normally associated with AI/Decision Support in the same fashion.

The Army is experiencing a major shortfall in advanced computing capability. A program has been initiated to acquire Cray class machines and to place them at the laboratories with the most computation intensive tasks (modeling, simulation, emulation, pure math research). Pre and post processing is an important part of utilization of supercomputers.

Networking is another important and costly element of super employment. Fiber optic networks and Ku band satellite connectivity should be considered as one possible means of integrating the processing power of supers into the Information Systems Resource. Pre and post processing could be done as a utility rather than on a dedicated but limited basis. Subsupers located at major processing nodes could serve multiple purpose in the Total Army Information Processing scheme. The availability of wide-band connectivity could also serve multiple purpose. The most important being Very Large Data Base updates at frequent intervals and in very short time spans.

DOS 4.X, OS/2 and enhanced versions of UNIX are emerging to provide the OS processing power and control needed to emulate the mainframe run environments while at the same time placing the processing and data base closer to the end-user.

Transport has improved but not as markedly as hardware. By use of more sophisticated encoding and multiplexing techniques, transport has been able to increase through-put in given situations in spite of the normal bandwidth limitations. Communications costs, as a unit measure, are decreasing because of the economies of scale that DCA has been able to implement. None the less, our communications costs continue to increase. The increase is the result of our growing demand for service and our inefficient utilization and management of these resources. Because of these developments, our communications costs are not expected to decrease at any time in the near future.

Given this situation, the redesign and the rewrite of obsolete software is one of the most critical factors in the modernization of the U.S. Army and the Army Information Systems.

4.3. Software

The area of software development, test, acceptance and performance evaluation is one in which there are few guidelines to follow. The three major documents which influence software development for and in the military are DOD-STD-2167A for Software Development, DOD-STD-2168 for Software Quality Programs and DOD-STD-7935 for Software Documentation and Life Cycle Management of Management Information Systems. The first two documents were originally written for the procurement of Mission Critical Computer Resources (embedded weapons systems). Today they are beginning to be applied to DOD procurements which were previously covered only under DOD-STD-7935 .

In an earlier paragraph, a key assumption was made. That assumption was that functionality -mission needs- is being met by the current applications. This is a default assumption. If the Army is using the application then it must be satisfying the need. Therefore, the first test, functionality, has been passed. The second test, performance, needs closer review. The performance of most, if not all, applications needs to be improved to meet the growing demands that are being placed upon them by the Army. The primary goal of any redesign and rewrite effort then must be to improve performance.

How does one go about improving the performance of an application? What performance standards and measurements are available for the proponent and users to gauge the relative performance of their application and the system in which it runs? What are the performance requirements of the proponent? Can the proponent express the performance requirements in terms the software developer can understand? Today these performance standards and requirements have been inadequately articulated and unfortunately there are few tools which can aid in this area. The proponent needs to apply some yardstick, some measurement against the current application to determine if that application's performance is acceptable. If the performance is not acceptable then it should become the target of a redesign/rewrite effort with possible migration as well.

The Air Force has taken the lead in the development of ways to measure software development and in software quality assurance programs. The Rome Air Development Center (RADC) initiated several efforts in this area over the last ten years. RADC, in conjunction with AIRMICS, sponsored the development of software quality measurements. These measurements are called quality factors. Each quality factor can be described in terms of software oriented attributes called criteria. Criterion can be described in terms of

metrics which are the quantitative measures of an attribute. The use of these measurements has been validated recently by two studies conducted for RADC.

The implementation of these techniques in new software development may portend the use of Rapid Prototyping, Artificial Intelligence and other new tools and techniques as useful ways to achieve the goal of improved performance.

5. CRITERIA FOR MIGRATION OF APPLICATIONS

What applications should be selected for migration? What criteria should be employed in the selection process? Where

will the processing actually be done after migration is completed? The analysis which is to be conducted must include a look at factors such as priority for migration, how migration will effect system integration, what standards apply to migration of the application (data element, transfer protocols, etc), what efforts toward Modernization/Redesign are currently in place or on-going which will impact the migration, and what resource management controls and coordination are required?

Unfortunately for the Army and the users of the systems in place today, ALL existing applications need to be improved. Not all require extensive rewriting or redesign, some can get by with minor modification or improvements in the methods with which they interface other applications. By using the priority scheme discussed earlier which is first look at go-to-war then g-to-work and within these categories look at them from oldest to newest. The Go-To-War applications would then get the first look. Incidentally, it appears that they are also among the oldest of the existing applications and therefore stand to gain the most from an infusion of technology.

After the Go-To-War applications were reviewed the Go-To-Work applications would need a similar analysis. In as much as they are the "work horses" of applications the potential benefits from their modernization are tremendous. Productivity gains here can't be measured in exactly the same way they are measured in industry but they can be measured in terms that are important to the Army. Those terms are (1) time and (2) administrative efficiency. By increasing administrative efficiency you can decrease the time needed to perform this part of the mission. That time, the Army's most important asset next to the soldier himself, can then be devoted to training. This lack of training time because of administrative burdens is the most critical issue currently facing the Reserve Component (RC) which is more than 50

percent of our total force. The AC faces the same problem but on more of a daily basis and from a slightly different point of view. AC forces simply have more time available for training than do the RC. Most of the routine administrative work in the sustaining base is performed by civilian employees of the Army. If the civilian employees perform their work properly then the AC soldiers will have the resources (Class I thru X, real estate, and information) to perform realistic training missions or simulations. The reality of the current situation is that the Army is continuously forced to ask these employees to do more and more work with less and less resources. Simply put, the work load has increased but the budget has either remained the same or has decreased. Political factors are the driving forces here and those forces are local as well as national and international. There is not projected relief in sight. Therefore we must work smarter and more efficiently with what we have.

6. METHODOLOGIES EMPLOYED IN APPLICATION MIGRATION

There are a range of methodologies available by which the migration of the applications can be achieved. The most important for this purpose of this WHITE PAPER are:

- Redesign and Recoding in Native Language
- Redesign and Recoding in ADA
- Optimization in Present Processing Environment
- Redesign of Processing and Transit Architecture

6.1. Redesign and Recoding in Native Language

Although current policy on the rewrite of application coding dictates the use of ADA, there are many cases where the retention of the native language is important enough to justify the action necessary to obtain a waiver from this requirement. Consider those programs which will not need extensive modification. Why change the language just for the sake of change. Guidelines exist which allow the use of native language when its is cost effective. Therefore use the native language for the minor modifications and then integrate bridge technology to improve interfaces with other applications as required.

6.2. Redesign and Recoding in ADA

DoD policy on the use of ADA has remained relatively stable over the last several years. The original policy prescribing its use in embedded weapons systems was been

expanded by the DISC4 to include its use in the redesign of Management Information Systems. Protests from industry have forced DISC4 and others to accept the position that if another language is more cost effective then it may be used in lieu of ADA. The marginal cost effectiveness of other languages in this situation is eroding rapidly and for all intents and purposes will disappear soon. The advantages of ADA are beginning to be better understood. The base of programmers is rapidly growing as is the scope of existing applications. While it is recognized that ADA is no panacea, it is the official language of choice in this area of migration.

6.3. Optimization in Present Processing Environment

DSI believes that the most important factor involved with the optimization of applications in their present environment and also involved in the consideration of migration technique is the level of inclusion of modern tools in the application and in the redesign and/or rewrite of the application. These tools specifically are Expert Systems and Decision Support Systems. The goal must be to fully integrate these tools into the application and not to have them as a separate package thus allowing their optional use. Their use is mandatory to achieve the improvements we are seeking. By integrating them into the application it is possible to achieve a high degree of transparency as far as the user is concerned. A comment from James Martin on this topic: "Expert systems -and non-expert systems, specifically artificial intelligence -are extremely important to the industry. They're one of the best hopes we have at the present time of increasing productivity. ... Today, most workers are knowledge workers, and its their productivity that we want to increase. That's what artificial intelligence is all about. ... Ninety-nine percent (of corporations) haven't come to grips with it as yet. The actual achievements of the 1 percent are spectacular. They show over and over again a more than 1000 percent improvement in the productivity of knowledge workers. ... Canon, the Japanese camera manufacturer, built a system that captured the skills and rules of thumb that go into lens design, which is an exceedingly complex process. The result was that the 80 lens designers - they didn't fire any of them - designed 14 times as many lenses... As a result, they brought one camera to market that was so innovative that it captured 35 percent of the marketplace for that class of camera."

6.4. Redesign of Processing and Transport Architecture

The redesign of processing and transport architectures are a worthy goal and must be addressed but are beyond the scope of the task. However, some of the other technology insertion

candidates which can be used to optimize performance of the hardware and transport equipment in the current architecture are as follows:

- o VLSI/VHSIC
- o GaAs
- o Read/Write/Erase Optical Disk
- o Natural Language Processing
- o Multi-Media RF
- o Multi-Media Networks
- o Dynamic Channel Allocation, Reconfiguration and Reconstitution
- o Cooperative Processing
- o Broadcast Agents
- o I-CASE
- o Object Oriented Programming

7. CONCLUSIONS

The development of a rational method to determine when to migrate an application can be accomplished.

The method of migration and the level to which it should be migrated must be tailored to the environment in which the application operates.

The technology used in the technology insertion effort must be reasonable technology in that it must be cost-effective and dependable while also being sophisticated and as state-of-the-art as possible.

That a Migration Plan based upon the findings and recommendations offered in at the conclusion of this contract be developed for the use of ISC. This Plan would detail the specific methods to be employed with each existing application selected for migration.

That the recommendations of Task 1 and Task 2 are an integral part of this Task and that they are part of the cornerstones upon which these and following conclusions and recommendations are offered.

8. RECOMMENDATIONS

The lead application selected for redesign and rewrite is ARPMIS

The SYSTEM proposed in a separate WHITE PAPER be used as the

primary tool for the work on ARPMIS and the demonstration of technology information extraction and consolidation.

The Task #4 deliverable be used as the vehicle to provide the level of detail of the work to be done in the effort described in the WHITE PAPERS of this contract.